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Space Matters: Barriers and Enablers for Embedding Urban Circularity Practices in the Brussels Capital Region

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Cities across Europe are increasing their ambitions to embrace a circular economy. In this context, a wide-ranging landscape of urban circularity practices is emerging. This article aims to elaborate on the spatial factors fostering or hampering the embedding of urban circularity practices (UCPs) in the Brussels Capital Region (BCR). The article, thus, addresses the following set of questions: What do circularity ambitions imply at the urban scale and what is the landscape of practices aimed at realizing urban circularity? What are the spatial implications of urban circularity practices? What could the role of urban design and spatial planning be in embedding and mainstreaming UCPs? These questions are explored both theoretically, through a literature review, and empirically, through case-study research. We show that access to spaces and land emerges as one of the most recurrent barriers to embedding UCPs in the BCR, and in other European cities too. We argue that while real estate prices are one of the main causes, it is not the only one. Frictions appear in political agendas where the need for more housing, productive spaces, land for urban agriculture, and green–blue infrastructures compete for the same limited space. Concurrently, the systematic building of the last available urban "void" (often brownfields) creates perverse logics of rushing the completions of "traditional" urban projects. Temporary occupations, often cited as exemplary circular practices, increasingly receive criticism when they become a structural limit to long-term perspectives. We have structured our arguments in four sections. First, we define our notion of urban circularity and UCPs. Second, we introduce a methodology and a framework. Third, four types of UCPs are selected for in-depth analysis. We conclude by highlighting potential leverages for working toward a circular spatial design and planning culture that facilitates embedding and mainstreaming urban circularity in the built environment.

Keywords: urban planning, urban circularity, circular cities, circular economy, urban resilience, more-than-human, inclusive spatial practices, Brussels

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1 INTRODUCTION

In the context of the 21st century post-industrial European cities, the notion of "circularity" is gaining momentum in architectural and urban debates on "sustainability": a shift toward more "circular" paradigms is advocated, yet a shared understanding of what are (or could be) their actual implementation in urban systems (i.e., cities, regions, metropolitan areas) is at a preliminary stage of

exploration (Ellen MacArthur Foundation, 2017; Marin and Meulder, 2018; Prendeville et al., 2018). Most of the contributions to the circularity debate are business-focused, promoted by lobbies and implemented by top–down actors, such as governmental institutions (Athanassiadis and Kampelmann, 2021). Our ambition is to widen the understanding of what circularity could entail on an urban scale and help shape a new culture of circularity, thereby being less consuming and wasteful, and more inclusive (attentive to social, economic, and environmental factors). By gathering empowering examples of existing urban circularity practices (UCPs) we wish to open this notion to a wider public, drawing insights on current socio-spatial practices and on how space matters in fostering the realization of urban circular ambitions. Accordingly, this article aims to elaborate on spatial factors (e.g., access to space and land) and on how they foster or hamper the longevity of UCPs in the Brussels-Capital Region (BCR). With this aim, the article addresses a set of specific questions: What do circularity ambitions imply at the urban scale? What is urban circularity (UC)? What is the landscape of practices aimed at realizing UC? What are the spatial implications of UCPs? What could the role of urban design and spatial planning be in embedding and mainstreaming UCPs? The premise is that such practices, in order to reduce the environmental impacts of logistics, must be in or at proximity of urban contexts (where the highest rates of consumption and waste of resources and goods occur).

Our contribution to defining UC aims at holistically framing what circularity ambitions imply at the urban scale by integrating reflections emerging in the course of this research with key notions developed in various research branches, namely, urban metabolism, urban ecology, and the first bodies of work-binding, circularity-inspired environmental strategies with urban design and planning. In literature, Marin and de Meulder first conceptualized the notion of urban circularity (UC) (2018), Williams worked on "Circular Cities" (2021), Kampelmann worked on the "Circularization of Territorial Metabolism" (2017), and Grisot wrote about "Circular Urbanisms" (2021). This article inscribes itself in this debate and uses UC as the terminology of choice. The debate around circularity at the urban scale is still in its initial phase, and significant effort is being put into the development of frameworks outlining the ambitions, actions, and leverages of circular cities (Marin and Meulder, 2018; Prendeville et al., 2018; Williams, 2019; Paiho et al., 2020; Williams, 2021a; Grisot, 2021). The benefits of implementing circularity strategies at the urban scale are also being studied (Williams, 2021b), and a plea for circularity approaches is emerging as potential pathways for solving some urgent urban issues exacerbated during the COVID-19 pandemic crisis (Williams, 2020b; Wuyts et al., 2020). Starting from these premises, our contribution aims at inscribing the notion of UC within three debates: 1) from an *Urban Metabolism* (UM) *perspective* by making explicit the ambition to lower the overall impacts on stocks and flows and footprints of settlements (Newman, 1999; Barles, 2008; Kennedy et al., 2011; Athanassiadis, 2016), 2) from an *actor-oriented perspective*, where inclusivity and empowerment are fundamental aspects in the mainstreaming of UC practices and, they by respecting all (Raworth, 2017), and 3) from a *more-than-human standpoint*—beyond culture-nature oppositions—that allows us to extend the reflection beyond anthropocentrism (Alberti, 2008; Wachsmuth, 2012; Haraway, 2014; Puig de la Bellacasa, 2017; Gandy, 2018; Tsing et al., 2020).

We also identify an existing "gap" between the world of abstraction of circularity-driven principles at the urban scale—designing ways to valorize resources—and the world of complex terrain experimentation and hands-on knowledge development (Prendeville et al., 2018; Verga and Khan, 2021). By providing a definition of UC and focusing on the UCP, we wish to contribute to bridging this gap. Therefore, we analyze the landscape of emerging practices aimed at realizing UC. We do so by gathering a set of new narrations of very different practices which contribute to the fostering of UC ambitions. If we follow Geels' dynamic multilevel perspective on sustainable transitioning (Geels, 2011), the challenge is now on how to "upscale" niches of innovations to link them together and stabilize them. In literature, one of the main challenges identified for the years ahead is to shift people's behaviors rather than implementing innovative technologies (Hobson, 2016; Pomponi and Moncaster, 2017; Korhonen et al., 2018b; Merli et al., 2018). Sectoral studies underline that UCPs are still part of the niches (Geels, 2011) and that a big step needs to be undertaken in order to establish them more broadly. By also including practices that exist besides top–down, technocratic, and innovation-driven ambitions, we wish to propose a focus shift. We propose the shaping of new inclusive and empowering narrations as a crucial challenge for the mainstreaming of UC ambitions. We aim to open the debate on how to foster UC to a larger urban population and help tackle structural socio-spatial inequities. This article outlines a landscape of practices that are multifaceted and scattered in order to nourish the debate on UC and UCPs beyond the easy-reach of green businesses and wealthier environmentally aware publics. Therefore, we also analyze UCPs that either existed way before UC ambitions were proclaimed or were tailored for less wealthy (or marginalized) people.

It is comprised of land (earth, soil, rocks, sand, etc.) bodies of water, infrastructures, buildings, below and above ground, air, humans and more-than-humans. Physical space is a support for humans and more-than-humans' activities and it undergoes constant modifications. We can also refer to the definition of portion of territories as "palimpsest" (Corboz, 1983) where signs of use and wear are layered. The notion of "spatialization" outlines the development of activities in a space over time. Physical space is uneven, showing very different characteristics according to the context. It is also a resource with different degrees of accessibility, unequally distributed (for example among humans) and it underpins socio-economic and political dynamics. Its use is deeply linked to ownership rights, real estate prices, cultural habits, nevertheless often more-than-humans can appropriate it despite these logic (this is the reason why we refer to "void" spaces, using quotes).

To date "circularity" ambitions at the urban scale are based on quantities of specific resources (or waste streams) or derived from reflections based on economic sectors and industries as most

contributions are either derived from urban metabolism (UM) studies the circular economy (CE). UM approaches, often described as "black boxes", struggle to relate quantification of stocks and flows of resources and waste to specific socio-spatial contexts (Coenen et al., 2012; Athanassiadis et al., 2013; Haberl et al., 2019; Williams, 2020a). In addition, many cities use CE as a way of re-branding through a new sustainable profile and create local jobs; they elaborate their policies within different tracks—often identified in economic sectors—and goals (Athanassiadis and Kampelmann, 2021). While studying Brussels' metabolism, Athanassiadis (2016) underlined how spatialization of stocks and flows represents a key challenge for metabolic approaches. We, thus, claim here that space matters in the fostering of UC ambition and UCPs, as space is a key urban resource and a limited one.

Last, we will tackle the question of how to relate to the role of spatial planning and design in embedding and mainstreaming UCPs. Policy makers, urban planners, and developers play a pivotal role in the fostering or hampering of the realization of more circular cities and regions as they can influence the building stock and creation of infrastructures and their maintenance, use and destruction, land use, and soil management (Williams, 2020a; Drobnik et al., 2020; Verga et al., 2020). A desire for circularity at the urban scale is developing and affirming itself, yet policymakers are still vague when it comes to embracing a bold and holistic agenda fostering circular ambitions and actions at the urban scale. A few test grounds for circular projects are emerging, but many more are "traditional" urban projects. Ongoing and linear developments slowly (but consistently) risk saturating the remaining significant urban "voids" with nonadaptable infrastructures built with "standard" construction materials, leaving fewer and fewer spaces for the creation of ambitious green–blue networks, for a thriving biodiversity, while preserving (and remediating) living soils.

These questions are explored both theoretically—through a systematic literature review—and empirically—through case-study research.We show how spatial issues are core factors in the mainstreaming of circularity ambitions and practices in cities. Accordingly, four types of UCPs, with one case study representing each type, are selected for in-depth analysis. In the first section, we provide our definition of UC and UCPs, structuring a framework on three tracks: the first one focuses on materials, the second one on actors, and the third one on terrestrial ecosystems. The methodology section starts by defining eight metabolic questions related to: energy, mobility and logistics, built environment, objects/stuff and nonorganic waste, organic matters and waste, food and beverages, land, soil, and water. We then introduce the framework of this research and provide examples of four kinds of UCPs dealing with: 1) *food and compost*, 2) *unexploited built environment*, 3) *construction materials,* and 4) *objects and textiles*. In the following section, analyses of the case studies are presented, first introducing the BCR context and then outlining the elaboration of a database and the atlas of UCPs. In the context of the BCR, these case studies include the following: 1) a charity foundation recirculating objects and textiles, 2) a movement creating housing and facilities in buildings within temporary-occupation contracts, 3) an urban farming project created in an unexploited site owned by a social housing company, and 4) a cooperative salvaging and reselling construction components. Subsequently, each kind of UCP is presented in detail through mapping at the regional scale followed by an in-depth description and analysis of a case study. A comparative analysis of the four in-depth case studies allows identifying key factors impacting the abilities of UCPs to establish and develop themselves, with a special focus on spatial factors. In the conclusions, we stress key concepts that emerged from this analysis and propose additional avenues for future research.

2 MATERIALS AND METHODS

2.1 Defining Urban Circularity and Urban Circularity Practices

Circularity ambitions are still mainly articulated within the CE discourse, a concept shaped in industrial ecology and ecological economics aimed at redesigning production–consumption patterns, while focusing on resource efficiency and with an emphasis on technological innovation (Ghisellini et al., 2016; Prieto-Sandoval et al., 2018). Despite its conceptual unclarity (Korhonen et al., 2018b; 2018a) and limitations in its definition (Murray et al., 2017), some efforts have been made to trace its historical development and outline its main characteristics (Kirchherr et al., 2017; Merli et al., 2018; Reike et al., 2018). CE is part of the sustainable development debate (Geissdoerfer et al., 2017) and can be inscribed in the discourse on planetary boundaries (Suárez-Eiroa et al., 2021). This notion is now being studied not only focusing on resource efficiencies but also in a socio-spatial manner (see, for example, Bortolotti et al., 2020). Risk of rebound effects occur, as scholars underline, when the focus goes predominantly to resource efficiency optimization (Arnsperger and Bourg, 2016; Zink and Geyer, 2017; Horvath et al., 2019). Often, the implementation of single-efficiency strategies without taking into consideration the main goal of the transitioning process (to lower the overall quantity of resources used and wasted) can become a threat and, thereby, delegitimize CE ambitions, easily labeled as easily green-washable.

Furthermore, CE approaches have been developed mainly at smaller scales (i.e., in industrial processes) and, therefore, lack of more holistic views and strategies. Scales of CE are mentioned in CE literature; nevertheless, the larger the level the vaguer (more abstract) the strategies indicated become (Kirchherr et al., 2017; Prieto-Sandoval et al., 2018). Furthermore, CE has been mainly embraced by the advocacy bodies of businesses and governments, while proposing an interpretation that fosters new green economic development (Ellen MacArthur Foundation, 2013; European Commission, 2015, European Commission, 2020b), yet scholars have pointed out the contradictions that could emerge in embracing CE in growth-oriented economic systems (see, for example, Ghisellini et al., 2016). The praise from these actors is for the emergence of innovation-driven initiatives, most often fostering top–down and technocratic approaches. Such

elitist approaches could hamper the spread of circularity ambitions as they address only a few wealthy and/or environmentally aware actors, while to embrace a paradigmatic shift, circularity ambitions should cross socio-spatial divisions and be shared among a spectrum of actors as broad as possible. Circularity is becoming a prominent notion also in the current urban debates; nevertheless, the visions and ambitions it underpins can be multiple: opposite worldviews result in a set of very different drivers and solutions, eventually diametrically opposed (Marin and Meulder, 2018). The first books on holistic approaches to circular cities have only recently been published (Williams, 2021a; Grisot, 2021). The main concerns outlined by the manifesto for a circular urbanism advocate for the end of urban expansions and land consumption, whereas Williams draws pathways in order to extend and democratize green–blue networks, manage and adapt infrastructures, and loop local materials and waste. Contributions on "UC" have also been provided from a landscape perspective (Marin, 2019).

In this article, the metaphor of circularity is not understood as a straightforward design strategy (i.e., aiming at closing loops) but as a notion able to trigger relevant questions. Our premise here is that through the lens of "circularity", we can spark pertinent questions and reflections on the current material configurations and the immaterial relationship we establish with them, as a way to rethink the interaction with the world we inhabit. Thus, we aim to widen the understanding of what urban circular ambitions could entail, with a focus on their spatial layouts. Circularity-driven ambitions allow us to question urban territories from an interesting angle. Within their boundaries, these circumscribed urbanities become places from which to exercise reflections on how to deal with the finite state of locally available resources, starting from space and land use. Difficult issues emerge, such as the choice of what activities are needed in future circular city regions, what kind of spaces and infrastructures they require, what public they involve, and the fundamental question of how these activities contribute to the making of more resilient and less consuming and wasteful cities. We inscribe the notion of UC within three tracks: 1) from a *UM perspective*, 2) from an *actor-oriented perspective*, and 3) from a *more-than-human standpoint*. The first track is based on UM approaches aiming at studying the direct and indirect environmental footprints of cities (Newman, 1999; Barles, 2008, Barles, 2017; Kennedy et al., 2011) and enhancing the circularization of territorial metabolism (Kampelmann, 2017; Ranzato and Grulois, 2018). Inspired by Arnsperger and Bourg's definition of "authentic circularity" (2016), this first track is based on the notion of "frugality" (*sobrieté*) as intrinsically linked to circular ambitions (in the French speaking world, this notion has been gaining momentum, see Lorrain et al., 2018; ADEME, 2019). Thus, "frugality" is proposed as a leading concept in circular ambitions to help prevent rebound effects (Arnsperger and Bourg, 2016). The second track of the definition of UC highlights the need to frame reflections on planetary boundaries within socially just foundations, respecting the wellbeing of all humans (as emerging from the donut compass drawn by Raworth, 2017) and by meeting everyone's foundational needs (Bentham et al., 2013). The third track of this definition addresses the need to integrate regenerative properties and the health (not healthiness) of soils, water systems, air quality, vegetation, living beings, and mineral elements in the definition of urban circularity ambitions (Williams, 2019). The adaptations of ecosystems occur in order to strengthen resilience in the face of climate deregulation (causing urban heat island effects, droughts, and floods), loss of biodiversity, and fertile soil (and nutrients such as phosphorus). A holistic urban approach shall, therefore, also take into consideration more-than-human worlds, beyond culture–nature oppositions, and promote a wider understanding of urban ecologies, their hybrid processes, and actors (Alberti, 2008; Haraway, 2014; Puig de la Bellacasa, 2017; Gandy, 2018; Tsing et al., 2020). It is also worth citing that the "One Health" approach (WHO, 2021), as an emerging notion mostly used in medical sciences that underlines ecosystemic interconnections. Thus, the notion of "circularity" can be an entry point to think of the city as a more-than-human environment.

To summarize, we define UC as aiming to promote more frugal (i.e., less resource-consuming and wasteful), resilient, and just behaviors and practices, where humans strive for the minimization of the overall net quantities of inputs (resources) and outputs (waste) of settlements (including extractions, manufacturing and disposing processes, logistics, transportations, and the needed infrastructures), while maximizing the valuing of existing local material stocks. UC also implies engaging with more-than-human perspectives, beyond utilitarian discourses opposing cities and natural ecosystems, cultivating the awareness that every actor of the ecosystem is connected. With this broader definition, we set the stage for addressing our main research questions (see *Introduction*) while gathering knowledge on the UCPs that integrates ambitions of inclusivity, socio–economic–environmental resilience and local communities' empowerment. Thus, UCPs are here intended as practices contributing to the transitioning of urbanities toward more resource-conscious interactions with the environment, promoting and facilitating more fugla (soberer) and just/inclusive lifestyles, while enhancing healthy ecosystem regeneration (i.e., reducing pollution, protecting space and enhancing biodiversity, water infiltration, nourishing living soils, etc.).

2.2 Research Framework

Based on our definition of UC, we propose a framework comprising two levels: three principal dimensions of UC (namely, space, materials, and actors) and a set of metabolic questions (MQs). The three principal dimensions of UC are presented in the framework (**Figure 1**) to guide the exploration of MQs throughout the case-study analyses. Thus, we have first selected the MQs and then the case studies of UCPs that are related to them.

We have made use of our dimension framework to analyze the case studies and draw insights from these practices and their ecosystems. We first analyze their spatial layout: urban morphology and architecture typologies, square meters, and

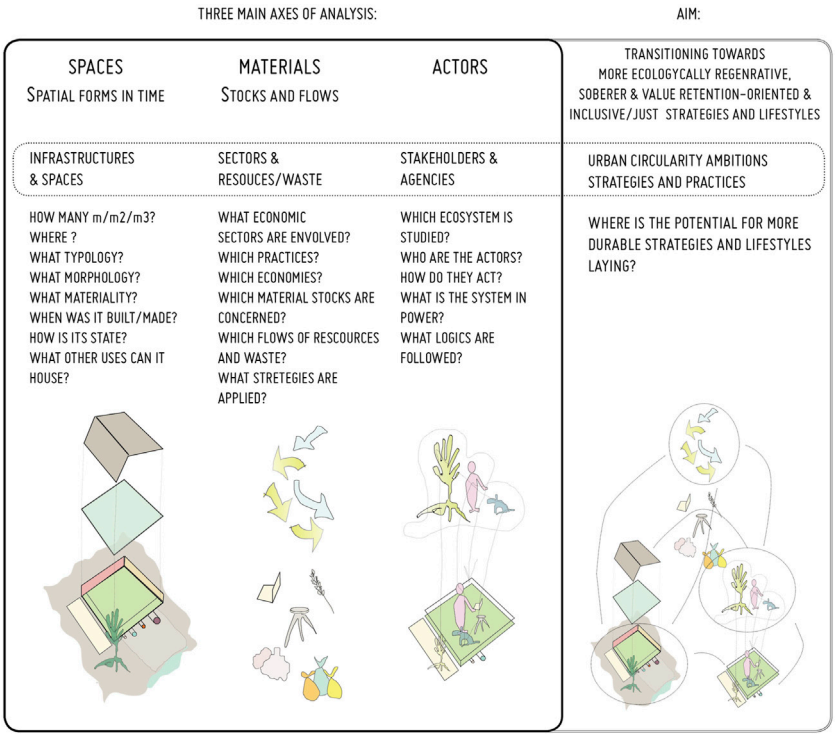

FIGURE 1 | Research framework: three tracks of analysis (spaces, materials, and actors) are identified, by the authors to enable a reflection across multiple disciplines and aspects on urban circularity practices (UCPs).

volumes. Afterward, we look at material urban stocks and flows tackled by the activities of these practices to study their functioning and impact. We then question actors and their role in fostering UC. This hybrid methodology allows us to take into consideration multiple aspects at the same time and spark reflections on the role of practices at the urban scale. This framework can help develop accurate insights on existing UCPs based on an in-depth qualitative and quantitative analysis of UCP. Interdisciplinarity is needed to decompartmentalize thoughts, study the hybrid objects that make up the urban environment, and tackle what is at stake for society today in the production of the city as a living system (Barles, 2016). Thus, this framework aims at structuring an analysis that can take multiple dimensions into consideration at the same time, irrespective of the scale. This tripartition evokes Tjallingi (1996), where "areas, flows, and actors" constituted the dimensions for decision making in strategic planning.

The MQs are representative of the resources and waste to be managed in a more circular way at the urban scale. They have been called MQs as they are essential elements to take into consideration when approaching UC in a holistic way: they are transversal avenues of research able to question and trace the material impacts of human actions. These quantities of resources and waste can also be referred to, borrowing from the core terminology in UM studies, as *stocks* and *flows*. By using this terminology, we wish to stress their longevity in urban contexts. Industrial ecology and metabolic studies traditionally estimate material flow analysis (MFA) of energy, materials, water, nutrients, and waste, including liquid and gaseous emissions (Barles, 2008; Kennedy et al., 2011; Athanassiadis, 2016; Voskamp, 2020). In Newman's extended UM approach to human settlements, the list changes. The inputs listed are land, water, food, energy, building materials, and other resources; while outputs are solid waste, liquid waste, toxics, sewage, air pollutants, GHG, waste heat, and noise (Newman, 1999). It is therefore important to also take land into consideration when studying cities' metabolisms, with a focus on fertile and lively soils (Keesstra et al., 2016; Breure et al., 2018; Drobnik et al., 2020; Puig de la Bellacasa, 2020) and land-use dynamics (Williams, 2020a; Grisot, 2021). Interdisciplinary approaches of UM are advocated (Broto et al., 2012; Barles, 2017; Dijst et al., 2018; Haberl et al., 2019), proposing complementary tools to MFA to engage with complex systems inherent to cities. The study of the stocks and flows of the built environment is prominent in CE strategies (Pomponi and Moncaster, 2017; Çimen, 2021), as in Europe the construction sector alone generates 38% of the total waste (European Commission, 2020a). Moreover, the concentration of people in urban environments brings consumption of goods and wastes to heightened levels, especially of goods that have a short lifespan and are used daily (i.e., food, beverages, packaging, etc.). In addition, long-lasting goods, such as various objects, appliances, furniture, and textiles, play a pivotal role in daily flows of materials consumed in cities. Each flow is the testimony of consumption and waste, and each flow forges logistics and transport circuits with it. In addition, taking mobility impacts into consideration is crucial when dealing with UC ambitions.

TABLE 1 | UCPs across four metabolic questions and categorized according to our definition of UC in three tracks: 1) value retention–oriented, 2) socio-spatial resilience–oriented, and 3) environment-oriented, by the authors.

Aim	(What) material ecosystem value retention strategies to reduce direct and direct and indirect footprints	(Who) actor ecosystem socio-spatial resilience	(Where) terrestrial ecosystem environmental healthiness
Urban circularity practices	More frugal lifestyles: consuming and wasting less, producing better: PRACTICES NARROWING, SLOWING, and CLOSING MATERIAL LOOPS	Widespread/mainstreaming of resilient (socioeconomic) and inclusive practices across society: ACCESSIBLE, SHARED, and JUST PRACTICES, REINFORCING COMMUNITY RESILENCE AND INTERSPECIES COEXISTANCE	Regeneration of ecosystems beyond anthropocentrism: PRACTICES OF REMEDIATION AND DE-POLLUTION (SOILS, WATER, AND AIR), REGENERATION OF CYCLES OF ORGANIC AND NON-ORGANIC MATTERS, NOURISHING SOILS, LEAVING SPACE FOR VEGETALIZATION, WATER INFILTRATION, AND BIODIVERISTY
Food and compost	Local food/beverage production (agriculture, farming, bees, etc.). Local food/beverage transformation (from vegetables, dairy products flower/bread/pasta, fruits, drinks etc.). Local food/beverage reselling. Drinkable water supplies	Access to land. Afforfable local organic food. Food-reuse collective kitchens. Free provisions of free drinkable water (filtered)	No use of pesticides and pollutants. Composting/cycling nutrients. Keeping soils alive and fertile. Growing flowers, plants, and trees and forests. Leaving land unexploited. Remediating soils. Permaculture and ecosystem synergies. Water infiltration
Built environment	More maintenance. More intensity/variety of use. More density. Sharing infrastructures. Reduce water consumption (use less, harvest rainwater, etc.). Reducing energy consumption (lower indoor temperature and/or selective heating of only few spaces, add insulation). Consume less land. Less changes/selective renovations. Ecological energetic renovations – locally sourced materials (firsthand or secondhand) – reusable materials – nontoxic bio-sourced materials. Design/build to last and adapt. Design/build for future disassembly. Design/build light-structures (movable homes)	Accessible prices. Social mixity. Hosuing and services also open to people in precarious situations. Creation of inclusive socio-cultural initiatives. Shared infrastructures (laundries, kitchens, gardens, etc.). Minimize car use and/or favor active mobility and public transport. Shared mobility. Secured spaces for bike parking. provide workshop spaces (i.e., bike repair). DIY. Sharing tools (i.e., for construction, maintenence, reparations, etc.)	Minimize impermeable surfaces. Maximizing vegetation, growing flowers, plants, and trees. Leaving some land unexploited. Onsite (off the grid) water management. Allow onsite water infiltration. Avoid the creation of strong winds. Remediating impoversihed and polluted soils. Choice of nontoxic materials. Choice of reusable elements. Choice of compostable elements
Construction Materials	SHRINK (MAINTAIN): Embracing the era of maintenance, as a cultural shift toward resource-consciousness, preventing consumption and waste. SLOW (ADAPT): Valorizing the existing design and build for future minimal interventions (adaptations), while extending the lifespan of goods, reducing overall consumption and waste. CLOSE (LOOP): Reuse a maximum of components and materials in their integrity. Optimize local flows and stocks of materials and their end life (reducing logistics, favoruing disassemblage, reuse of parts). Recycle only what cannot be reused. Limit waste and its management. Create new synergies between industries. REPLACE: more sustainable material alternative is designed or manufactured to replace the 'standard' ones	Affordable/accessible prices for local (circular) non toxic materials. Sharing tools (i.e., for construction, maintenence, refurbishment, etc.). Creation of inclusive socio-cultural initiatives. Shared infrastructures and workshop spaces (i.e., for DIY).	Optimize/share infrastructural failities (for production, logistics, retail, salvaging components/materials and recycling). Minimize impermeable surfaces on the ground. Do not pollute soils and water. Remediate soils and water. Choice of nontoxic materials. Choice of reusable elements/materials. Choice of compostable elements/materials.
Objects/Stuff	SHRINK (MAINTAIN): Embracing the era of maintenance, as a cultural shift toward resource-consciousness, preventing consumption and waste. SLOW (ADAPT): Valorizing existing goods, repairing and adapting them to new needs. Design and produce long-lasting goods, needing minimal future interventions. Repair and extend the lifespan of goods, reducing overall consumption and waste. CLOSE (LOOP): Optimize flows and stocks of materials and their end-of-life (logistics, disassemble, reuse of parts). Reducing waste and its management. Creating	Affordable/accessible prices for local (circular) non toxic goods. Sharing tools (i.e., for maintenence, reparations, refurbishment, etc.). Creation of inclusive socio-cultural initiatives. Shared infrastructures and workshop spaces (i.e., for DIY). Cultural movements/projects	Optimize/share infrastructural failities (for production, logistics, retail, salvaging components/materials and recycling). Minimize impermeable surfaces on the ground. Do not pollute soils and water. Remediate soils and water. Choice of nontoxic materials. Choice of reusable elements/materials. Choice of compostable elements/materials

(Continued on following page)

TABLE 1 | (*Continued*) UCPs across four metabolic questions and categorized according to our definition of UC in three tracks: 1) value retention–oriented, 2) socio-spatial resilience–oriented, and 3) environment-oriented, by the authors.

Aim	(What) material ecosystem value retention strategies to reduce direct and direct and indirect footprints	(Who) actor ecosystem socio-spatial resilience	(Where) terrestrial ecosystem environmental healthiness
	new synergies between industries. REPLACE: more sustainable material alternative is designed or manufactured to replace the 'standard' ones		

Therefore, the set of MQs can be many, and a non-exhaustive list could be as follows: 1) *energy*, 2) *mobility and logistics*, 3) *built environment*, 4) *objects/stuff* and *nonorganic waste*, 5) *organic matters and waste*, 6) *food* and *beverages*, 7) *land* and *soil*, and 8) *water*. We underline here that the challenge is to research cities while also keeping multiple metabolic questions in mind and at all stages of urban analysis, design, and planning. Until now, research mainly targeted one or few metabolic questions at a time, sometimes by focusing on a material stock and flow or targeting an economic sector. In this study, we focus on four metabolic questions and their associated case studies dealing with them, namely: 1) *local food production and organic waste composting*, 2) *reuse of unexploited buildings*, 3) *recirculation of construction components and materials*, and 4) *recirculation of locally available objects*, *appliances*, *furniture*, *and textile (stuff)*. This choice, as justified and elaborated in (Sections 1.4.1–2.4.4), is deliberate and derives from a selection by the authors of the numerous case studies listed in the database. Thus, the methodology presented can be applied to any other metabolic question and case study. Each set of analyses can enrich the knowledge on the material stocks and flows, spaces, and actors these metabolic questions entangle. In **Table 1**, the four kinds of UCPs (corresponding to the four metabolic questions elaborated in-depth in this article) are presented and categorized according to our definition of UC (materials' value retention, socio-spatial resilience, and environmental healthiness). Thus, we propose three tracks of reflection on UC: each one is defined by an aim and some examples of UCPs. In the first track, we mobilize the typical CE frameworks: ladders of value retention options, also called R-imperatives (Achterberg et al., 2016; Bocken et al., 2016) (Kirchherr et al., 2017; Reike et al., 2018; Çimen, 2021).

2.3 Context: Brussels Capital Region

In the introduction, we discussed the need to spatialize ambitions and delineate them to specific contexts, in this case, the BCR, where circularity ambitions have been published in the Circular Economy Regional Plan (PREC) (Bruxelles Environnement, 2016). Urban metabolism studies have been an important contribution to the shaping of the PREC (Bortolotti and Ranzato, 2016; Athanassiadis and Kampelmann, 2021). The PREC was launched in 2016 (for a duration of 4 years), and about 13 million euros were dedicated to the testing and implementation of CE. It was divided into four strategic tracks: transversal actions, sectoral actions, territorial actions, and governance actions. The spatial track was the vaguest of the four; thus, this research aims at nourishing the understanding of what circularity-inspired ambitions could be at the territorial scale. The three main regional challenges are as follows: 1) *low incomes and poverty spread across a large part of the urban population*, 2) *lack of affordable housing*, and 3) *environmental and ecological urgencies in times of climate deregulation and geopolitical instability* (e.g., floods, biodiversity loss, urban heath island effects, local food production, etc.). The BCR is very polarized as some inhabitants have remarkably high incomes, while 30% of the population is in danger of being below the poverty threshold (IBSA, 2021).

Real estate, industrial areas, brownfields, and in-built open-air areas are under enormous pressure in the BCR. Three main regional agendas emerge among many and compete for the same 162 km^2: 1) finding more space for housing (in a density rise perspective), 2) keeping space for the productive city and local employment, and 3) enhancing green permeable spaces for biodiversity, off-the-grid water management, heath-island control, local food production, and biowaste management. According to the cadaster, built-up areas have increased from 43 to 60% in 14 years. We are currently witnessing a systematic filling of urban land, while many buildings are kept empty by property speculators, mainly large real estate groups that specialize in office building stocks. The resulting vacancy rates of the building stock of office buildings are significant. In 2020, 7.7% (i.e., 978,424 m^2 out of 12,701,973 m^2) of office spaces were counted as "commercialized and vacant" (perspective.brussels, 2021). A team of researchers at the ULB/VUB, mandated by the Secretary of State for Housing in view of the establishment of a cadaster of unoccupied dwellings, estimates the vacancy of buildings affects, in the BCR, nearly 10,000 buildings, that is to say between 17,000 and 26,400 dwellings.

2.4 Atlas of Urban Circularity Practices: A Case Study–Oriented Research

Case study–oriented research is used as a methodology to investigate new concepts, such as circularity ambitions, at the urban scale (Marin and Meulder, 2018; Prendeville et al., 2018; Williams, 2021b). The current debate on transitioning toward more circular approaches can be enriched by a closer look at spaces both at the urban scale as well as at case studies of circular practices. The focus of this research is on existing practices that take place in the BCR, where we analyze specific case studies in-depth. Our approach here is reversed compared to typical UM

studies: instead of studying material quantities (resources and waste stocks and flows) entering and exiting urban systems, we study UCPs as practices fostering more frugal lifestyles and regenerative healthy ecosystems in just and inclusive manners. The four case studies and how they were selected will follow. There is quite a lot of case study research on circularity at the urban level. Some literature compares different cities' policies and transition drivers (Marin and Meulder, 2018; Prendeville et al., 2018; Athanassiadis and Kampelmann, 2021; Campbell-Johnston et al., 2019), others study contexts to be redesigned in more circular manners (Grulois et al., 2018; Marin and De Meulder, 2018; Marin and De Meulder, 2021), and others study emerging circular neighborhoods (Williams, 2019; 2021a), while many tackling single stocks and flows: energy, organic waste, mobility, water, etc. (Gandy, 2004; Williams, 2010; Florentin, 2015; Juwet and Ryckewaert, 2018; Bortolotti, 2019). It is common to find scholarly and gray literature on single industries (construction sector, textile industry, food production, etc.). There are also many examples in gray literature and on organizational websites showcasing "good practices."

Over the last 3 years, we have created a database of UCPs. We selected UCPs throughout three main data collection methods: desktop research of existing databases and clusters (i.e., consulting websites already mapping initiatives), desktop research based on word matching (in French and Dutch), and first-hand experiences. This database consists of multiple spreadsheets indicating a list of practices and available data (such as name, location, year of foundation, ongoing/end year, website/contacts, domain/category, circularity strategy, and material stocks and flows tackled). Ideally, to perform a socio-spatial analysis, information was also gathered on space typologies and urban morphologies, and on the legal status of site exploitation. It also became important to consider the agency of these UCPs by mapping actors (when possible).

Through a geographic information system (GIS) (using free and open-source program QGIS), we constituted an atlas of UCP, focusing on the BCR. To research the gap between top–down circularity ambitions and on the ground complexities of hands-on practices, insights were interwoven at two scales: at the urban/regional scale by mapping practices, and in the form of a database and an atlas of UCP; and at the smaller scale through in-depth case studies to grasp terrain complexities, perform surveys of spaces, and conduct semi-structured interviews with actors.

2.4.1 Why Practices of Local Food Production and Compost

We have chosen food and compost as they are predominant in the UC debate of the BCR. In the BCR, 30,000 people are food-insecure and rely on food welfare, which represents 35% of the population living below the poverty threshold and being exposed to risks related to poor diet. In parallel, urban agriculture in Brussels has 205 ha of agricultural land and 161 potential hectares of agricultural land which is in direct competition with other urban issues (SAULE, 2020). Between 2015 and 2018, professional agriculture doubled from 16 projects to 32 (and there are 84 new vegetable gardens in schools). The number of collective vegetable gardens, including roof top gardens, increased by 33% (79 ha spread over 392 sites) but not in terms of surfaces as the land to cultivate is diminishing. Only 10% of the inhabitants of Brussels declare that they grow food in the city, whereas the objective of the regional program Good Food was to reach 30% of the population by 2020; in 2018, only 0.1% of Brussels' fruit and vegetable consumption was produced within the territory, and 1,600 ha are needed to reach the target of 30% consumption rate by 2035 of fruit and vegetable (in kilos) grown within a range of 10 km around the BCR (Bruxelles Environnement, 2015; SAULE, 2020; Lestrange et al., 2021). Studies on agroecological practices in the BCR are being carried out, and there is momentum in questioning the role of fertile and living soils in cities (Cahn et al., 2018; Lestrange et al., 2021; Metrolab brussels, 2021). In addition, practices focusing on biowaste management in the BCR have recently been studied and showed a great potential for the local management of household waste. These studies underlined the key need to start recovering elements (such as phosphorus) that are currently experiencing a global shortage and are crucial in sustaining fertile soils. Such studies also insist on the importance of citizens' roles and involvement in collective compost actions (Muynck et al., 2018; Bortolotti, 2019). Thus, the focus of such studies was to find systemic ways to save the richness of nutrients contained in local organic waste in order to return it to the soils and guarantee the cycle of such precious fertilizers as currently 30–60% of household waste is organic and could be managed differently than through logistics and energy-intensive waste treatments (that is combustion with energy recovery and biomethanization in an plant over 100 km away from the BCR) (Bruxelles Environnement, 2018).

2.4.2 Why Practices of Reuse of Unexploited Buildings

Studies on building adaptive re-use, and especially heritage buildings, have been promoted and financed by the European Union. By reusing the existing building stock, not only the flows of construction materials of an eventual demolition and reconstruction are spared (and their heavy environmental impacts) but also historical building and their stories can be salvaged and reinscribed to suit cities' contemporary needs. From a planning perspective, the adaptive reuse allows cities to engage with urban renewal projects by phasing them (and eventually testing ideas and involving the citizens). A handbook has been published for municipalities to engage with sustainable and circular reuse of urban spaces and buildings (Urban Agenda for the EU, Arco, Città di Prato, and Valerio Barberis, 2019). Many elements come at play in adaptive reuse strategies, for example, the question of how to develop a more inclusive governance of the building stocks that are currently underused and in need for reconversions as public authorities cannot manage and finance the reconversion of all (heritage) buildings. The Horizon 2020 project *Open Heritage* also focuses on non-touristic heritage sites to test ways of providing spaces for marginalized groups (OpenHeritage, 2019).

Temporary occupation projects in the BCR have become widespread, often framed within large redevelopment sites from industrial activities to mixed one (i.e., housing accompanied by other functions). The discourse we have often found mentions these precarious occupations as "win–win" situations. The BCR *Urban Development Corporation SAU-*

MSI is responsible for carrying out major urban development projects and constructing public facilities of regional significance. They are the larger commissioners of temporary occupations (an example is the project *SeeU* in Brussels). Two other main actors are worth mentioning: the public real estate company *Citydev*, in charge of developing public projects', and *Entrakt*, that gives buildings temporary functions. In addition, a set of nonprofit organizations are structuring these kinds of practices and propose socially inclusive activities and services. Two main examples are *Toestand zvw* and *Communa asbl*, specialized in large urban sites, public spaces, and buildings in conversion. Artists are also important actors in this domain; they often occupy (temporarily) unexploited sites. Cultural and artistic collectives are starting to question what such a nomadic and precarious status implies. For example, a rising movement tackling the constant struggle for urban spaces for artistic and cultural practices is *Permanent*, exploring ownership models to ensure their longevity. In 2020, *Fair Ground Brussels* was founded, which is a real estate cooperative with the mission to create affordable housing and allow associative actors to access spaces. The aims were to develop real estate projects in a nonspeculative way by applying the community land trust model based on the separation of the ownership of the land from that of the buildings, perpetual accessibility through nonspeculative resale conditions, and shared governance. On the other hand, we also see private initiatives that invite temporary occupations of UCPs to increase their real estate capital while waiting for the approval of their redevelopment project (an example is the *Circularium*). Other projects are also concerned with the temporary use of empty buildings, namely, "squat" and temporary occupation movements, such as *Woningen123Logements*. It is interesting to underline that the latter example is also focusing on housing by giving access to accommodations to people often in precarious social or economic situations such as, but not limited to, worker *sans-papiers* and lower-income groups. *Woningen123Logements* collaborates with the nonprofit organization *FéBUL-BFUH*; they played a pioneering role in the promotion of temporary occupation agreements. The signing of the temporary occupation agreement for the *123 Rue Royale* was the first time that such a large building was put at the disposal of a collective made up of so-called precarious people who wanted to live in *auto-gestion* (self-management) (FéBUL, 2017).

2.4.3 Why Practices of Recirculation of Local Construction Components and Materials

If until recently the focus of circular economy was primarily on *recycling* practices (for example, crushing demolished concrete and bricks to make granulates for infrastructure bedding), we now see that public and private initiatives are embracing *salvaging* and *reuse* practices (rather than r*ecycling*). Thus, the focus is shifting to the more virtuous steps of the 10 R-impertives ladder (Reike et al., 2018) (dealing with useful life extensions of goods, rather than with their end-of-life). Nevertheless, the percentage of *reuse* stays limited compared to *recycling*. Many terrain actors estimate that nowadays, reuse is less than 1% in Belgium (Rotor and Van Hoff, 2020, with a perspective of growing up to 5%. Some say that technically, it could reach 25% (Interviewee #1, 2019). In 2016 and only in the BCR, 628.000 tons of waste from the construction sector was produced, and around 91% of it was being downcycled through recycling. A growing number of circular economy practices are the ones dealing with selective deconstruction (instead of demolition) and reselling of reclaimed building components. An online database of these (*Opalis.eu*) started documenting Belgian resellers and is now expanding to the rest of Europe. Nowadays, in the BCR, few of these practices are implemented: *Rotor DC* and *BatiTerre* reselling components through an online-shop and a physical one. Others practices such as *Rova*, *Marbrerie Combré*, and *Design with Sense*, among many others, offer services on how to repair, refurbish, and reuse reclaimed elements in construction. A business cluster (*Ecobuilt*) comprising architecture offices, consultant firms, contractors, and others is developing expertise in the making and pioneering of circular projects. These practices appear to be in expansion and are often supported by public subsidies. The update of the PREC in 2019 introduced three new measures to foster reuse and develop local value chains of mining construction components and materials in the BCR (BBSM, 2021).

2.4.4 Why Practices of Recirculation of Locally Available Objects, Appliances, Furniture, and Textiles

The BCR has a long, continued tradition of flea markets and secondhand reselling. An example is the daily market of *Jeu de Balle* in the very center of Brussels and *Le Petit Rien-Spullenhulp*, the UCP which will be described more in depth in the next section. This nonprofit organization is one among many others working on goods recirculation within the social economy. The social economy is publicly subsidized and allows for the employment of people under an advantageous fiscal regime. In countries such as Belgium, where labor is heavily taxed, it allows companies to accomplish labor-intensive tasks (i.e., CE actions such as repairing, cleaning, refurbishing, etc.) while staying competitive in the overall secondhand market. Before the notion of CE was promoted by the BCR, most value retention practices were performed by social economy actors grouped under the federation *Ressources asbl* throughout Brussels and Wallonia. Other businesses and associations—not necessarily working within the subsidized economy— (such as *Cash Converter*, *Pele Mele, Oxfam, Salvation Army, Emmaus/la Poudrière*, and *CF2D*) work in this domain, creating a very multifaceted and dense panorama of UCPs dealing with the recirculation of objects.

3 RESULTS

3.1 Atlas of Urban Circularity Practices

The atlas of UCP is presented in the form of two sets of maps, the first one showing key territorial elements of the BCR and the second pinpointing UCP. These maps are complementary and should be read synchronically. In **Figure 2**, eight maps show the following: 1) an aerial view of the BCR and the

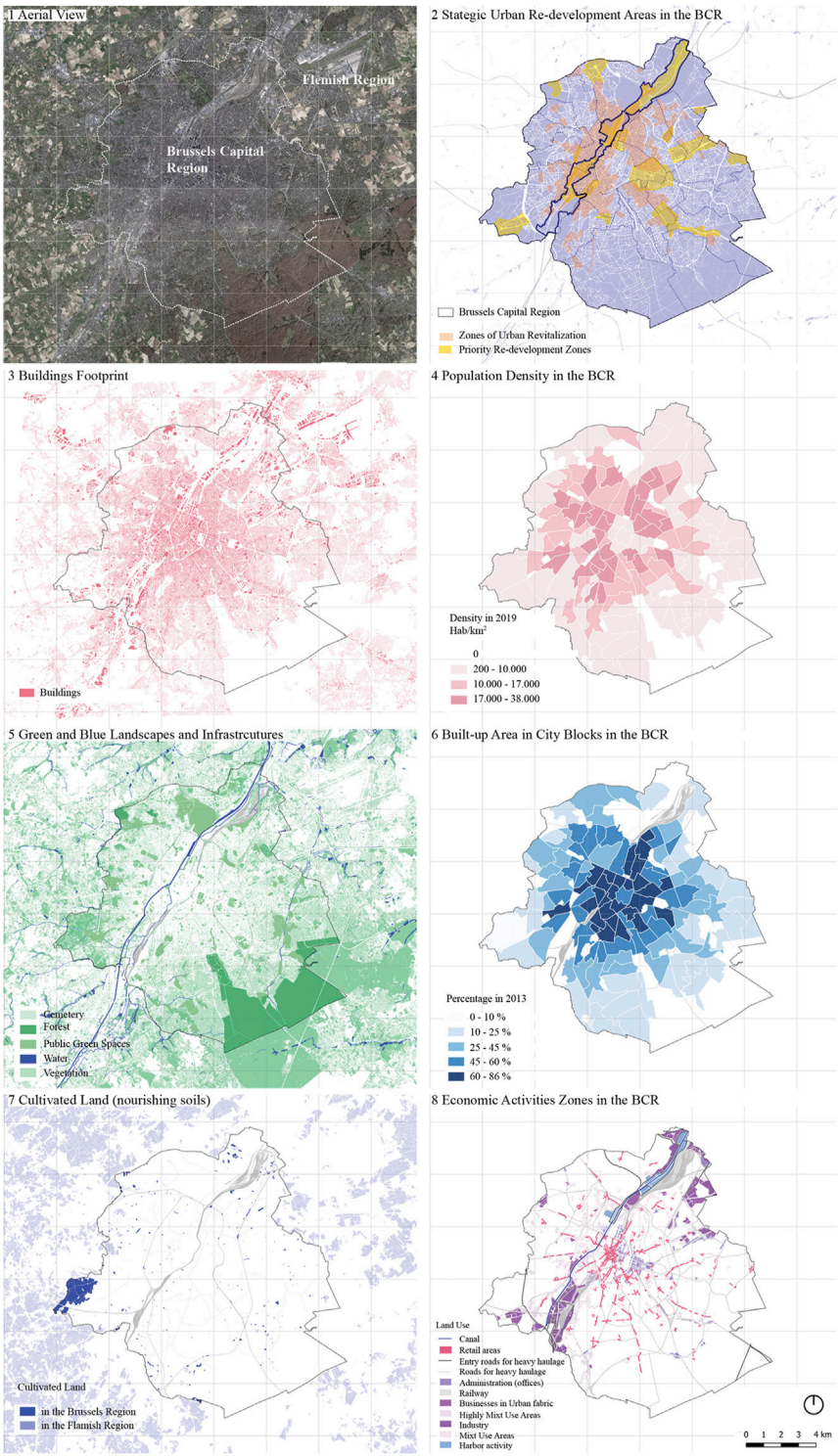

FIGURE 2 | Brussels Capital Region territorial figures, by the authors.

neighboring Flemish region, 2) the footprint of buildings, 3) green and blue landscapes and infrastructures, 4) cultivated land, 5) the strategic sites that the BCR is planning to redevelop, 6) the population density (habitants/Km^2) divided per statistical sectors, 7) the percentage of buildings' footprints in urban blocks, and 8) a selection of

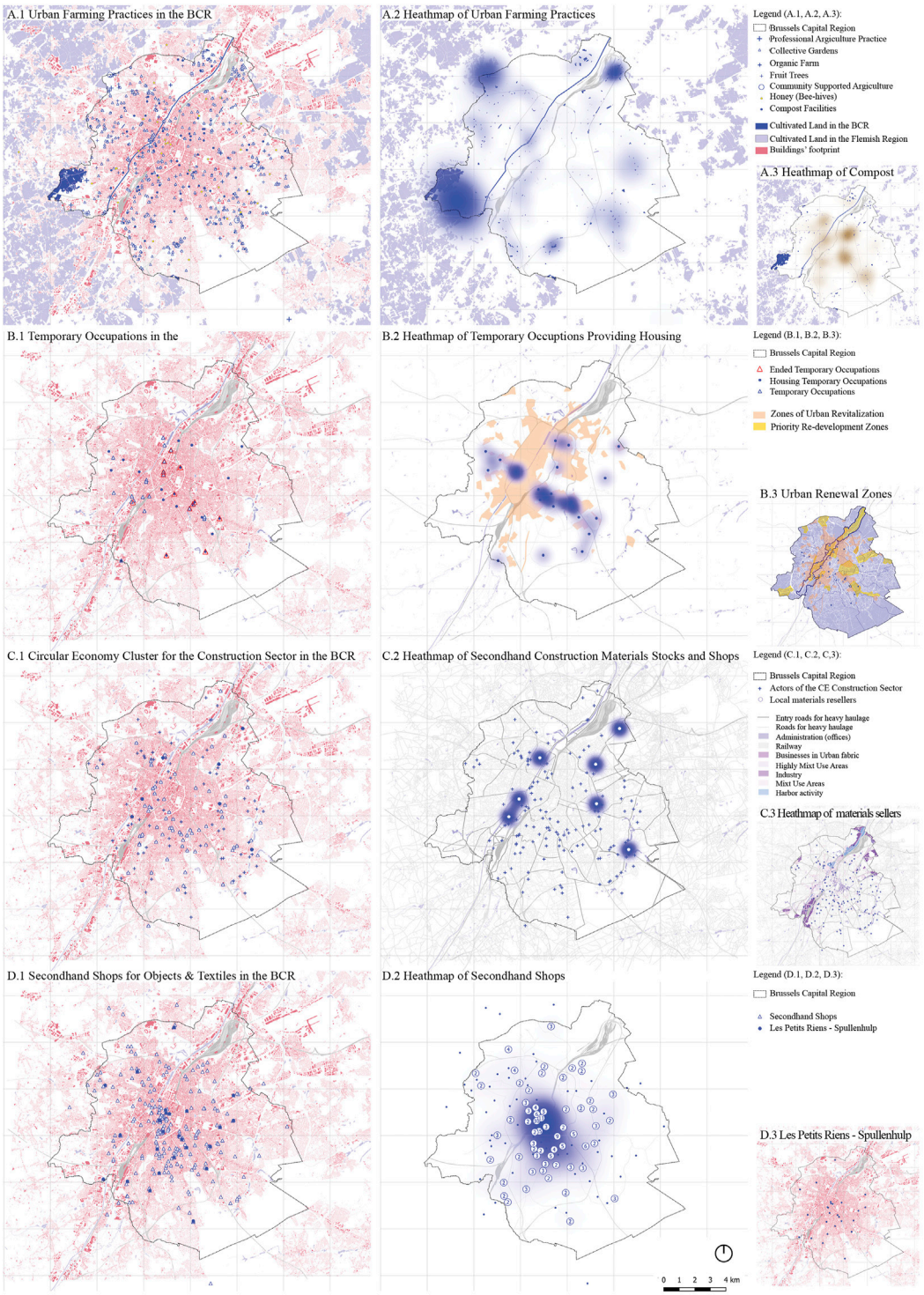

FIGURE 3 | Extract of the atlas of urban circularity practices in the Brussels Capital Region, by the authors.

land use focusing on productive and economic activities. In **Figure 3**, another set of maps pinpoints UCPs. Two major outcomes of the second mapping exercise are as follows: 1) to create an urban portrait of UCP including historical/ embedded ones as well as start-ups/innovative, bottom–up or top–down, technocratic, or low-tech; 2) to allow a spatial analysis based on their localization. Each set of practices is presented with two main maps describing the regional

FIGURE 4 | Location in the BCR, aerial view from Google Maps, plan, and photos from the website "Ferme du Chant des Cailles" (consulted in June 2021). By the authors.

TABLE 2 | Summary of the case study "*Chant des Cailles*", by the authors.

In depth-case study	Chant des Cailles URBAN FARMING
Spaces	Fertile land (large parcels for professionals and smaller ones for noncommercial use), greenhouses, meadows, cool storage space, compost facilities, transformation atelier for dairy products, market space, gathering space, and didactic space. 2.5 ha of fields (of which 10,500 m^2 is professionally cultivated land + 7,500 m^2 of meadows + 850 m^2 of aromatic herb fields +3,600 m^2 of collective vegetable and composting garden + 590 m^2 of shared gathering space). Recent off-site expansion: 6,900 m^2 of extra agriculture land in the nearby municipality of Overijse + an extra 640,000 m^2 of meadows for sheep in a nearby St. Anne's convent, in Rouge-Gorge and in Overijse (through the association *Terre-en-Vue*).
Flows	Vegetable production (feeding 380 people): 284 varieties cultivated and 1,046 m^3 of water used for watering (three times more than in 2017). Flowers. Collective compost. Aromatic plants (41 subscribers to self-picking of aromatic plants): 170 kg of fresh plants that became 42 kg of dried herbs becoming herbal teas and spices. Dairy products from March to October (feeding 170 subscribed households and + eight peasant agriculture solidarity buying groups + markets three times a week): 160.00 L of sheep milk transformed in yoghurt, cheese, ice cream, apple juice, chutneys, and applesauce (from 2.5 tons of apples from the nearby orchard of St. Anne's), meat, and wool.
Actors	Professionals (peasants, farmers, herbalists, dairy product processors, and sellers) in total equivalent to 18 full-time positions + 33 interns. In the vegetable garden: equivalent to 2,9 full-time positions + 2 equivalent full-time interns. In the herbal garden: 4 interns + 6 volunteers. In the sheep breeding: 4 full-time shepherds + 19 interns + 30 volunteers + 45 sheep for milk + 6 sheep for the eco-pasture (maintenance of green urban spaces with sheep grazing). Composting "masters" and network of composting actors. In the collective garden: 88 nonprofessional gardeners. Subscribers: 179 households subscribed for the vegetables (268 adults + 136 kids, equivalent to 380 people fed, of which 12% of people living in the surrounding social housing), 170 households subscribed for dairy products. Other actors: farming experts, volunteers, researchers, visitors, bees and other animals, plants, flowers, living soils (worms and other organisms), and minerals and nutrients, etc. (. . .)
Founding year	2012-ongoing (threatened by disappearance)
History	Urban farming project developed in an unexploited site of a social housing development
Location	Peripheral residential area comprising a *cité-jardin* of the '20s
Legal structure	Cooperative and nonprofit association

ecosystems of spaces and actors and a smaller complementary map. The first map pinpoints multiple kinds of UCPs dealing with the chosen metabolic question, while the second map performs a heatmap analysis to identify clusters of practices in the BCR, and thus their "intensity" across the region. Heatmaps are graphical representations that allow for the

FIGURE 5 | Location in the BCR, aerial views from Google Maps of the location and photos from the website of 123 rue Royale consulted in September 2021.

TABLE 3 | Summary of the practice "*Woningen123Logements*" (at 123 rue Royale).

In depth-case study	**Woningen 123 Logements "squat" (Temporary occupation) housing project in an uxeploited office building**
Spaces	Total of 4,300 m^2 of a former publicly owned office building: Seven floors of approximately 500 m^2 + ground floor of 800 m^2. The former office building was transformed in approximately 56 individual large bedrooms (20–30 m^2) to house one to 3 people (according to families and household structures), seven kitchens (one per floor) shared by the inhabitants of the floor; large shared spaces near the kitchen, toilets, and showers at each floor. The shared spaces with the city were: a bike workshop; a collective kitchen where to cook large meals once a week with the leftover ingredients of large distribution (on the principles of free price contributions); a bar and events space with a windows towards the street; a shared deposit to daily gather unsold food; and a free shop for clothing, appliances, and objects.
Flows	Unsold food redistribution on a daily basis (on an estimation of 7 kg of food per day every day, it would be 2,500 kg/year) Bike repair sharing and exchanging of clothing, objects, appliances, plants, etc.
Actors	56 official inhabitants; extra inhabitants being part of the same household of residenses; Temporary guests: nonprofit association *Woningen123Logements*. Public institutions owning the building. Community of participants in the various activities. Squat communities (. . .)
Founding year	2007–2018 (ended)
History	"Squat" movement occupying a non exploited publicly owned office builing for housing
Location	Central area in the administrative district
Legal structure	Nonprofit association

visualization of large datasets in a synthetic and intuitive way. The following section presents an in-depth analysis of a case study for each of the four metabolic questions (food and compost, built environment, construction materials, and objects). The result part of the article is, therefore, constituted of two scales of analysis: mappings at the regional scale and a zoom-in on single UCPs.

As discussed, food production and composting are a key UCP in the "circularity"-oriented agenda of the BCR. In the west part of the BCR, there is the main area of land, connected to the historical fertile land of the *Pajottenland*. Nevertheless, the BCR is showing a well-distributed set of smaller urban farming practices in denser contexts, where communities organize small vegetable gardens and compost facilities. If we look now at the landscape of temporary occupations of exploited buildings and sites, we notice that they are deeply linked to zones undergoing either large urban projects (re-development areas) or smaller urban renewal programs. Such occupations

FIGURE 6 | Location in the BCR, aerial views from Google Maps, photos of the courtyard and storage. Collage by the authors.

TABLE 4 | Summary of *Rotor DC* practice.

In depth-case study	***Rotor DC* salvaged construction components and materials' Reselles**
Spaces and stocks	Total of 5,200 m^2 as part of a former chocolate factory: 250 m^2 of offices (heated space), 1,500 m^2 shop with a small workshop and storage (for delicate and small things), 150 m^2 of exterior independent workshop space (for wood works, cleaning, and refurbishing heavier things), 850 m^2 of storage on the ground floor, 2.500 m^2 of ground floor open-air logistics space (including storage, parking, charging–unchanging, open-air workshops for tiling and sanitary cleaning with acids). Out of 5,200 $m^{2,}$ 1,750 are covered areas, of which 250 m^2 are heated. Type of spaces: offices, archives, meeting room, workshops (to clean, refurbish, and prepare to sell electric equipment, wood, tiling and sanitary, stones etc.), storages (racks to pile components), shop, photography shooting area, etc.
Flows	160 tons of materials (in 2018, less than in 2017) bricks, ceiling, doors, floors, furniture, garden elements, metallic hardware, lighting, objects, partition walls, sanitary equipment, stairs, technical equipment, wall cladding, wood, pieces of former scenography, and artworks
Actors	Employees: Twenty-four people working in both structures (Rotor asbl-vzw and Rotor DC) for a total equivalent of 16 full-time positions (in 2019): 1/3 working in Rotor DC and 2/3 in Rotor asbl-vzw (almost all people working there have a higher education degree). Other actors envolved: demolition companies, buildings owners, architects, engineers and consultants, clients, public institutions, private institutions, nonprofit associations, buildings, construction components, and materials (. . .)
Founding year	2016-ongoing (relocating)
History	Nonprofit association of people active in architecture debate that developed a spin-off cooperative where to test how to recirculate construction components and materials
Location	Central former industrial site along the canal undergoing urban renewal
Legal structure	Cooperative and nonprofit association

often take place during the "*limbo*" times needed to develop a real estate project; we see a constant movement from one site to the next. Housing projects are an important part of these temporary occupations, but they never occur in strategic zones undergoing development, where more creative and economic activities are privileged. Squat movements occupy mostly unexploited office buildings (in administrative zones) and focus on housing. The panorama of businesses of local construction materials is much less developed. They are concentrated in mixed-fabric zones next to infrastructures or along the canal, where the port is and where many large warehouses are located. However, it is important to notice that the canal area is one of the strategic redevelopment zones in the region, and that practices located there most often have temporary leasing contracts. Most of these spaces will welcome new dwellings, while industrial or productive activities will be limited. In conclusion, we can observe that the landscape of secondhand shops is very well-developed, and

it embraces the whole BCR. A strong presence is in the city center and around the neighborhood of the *Marolles*, where a flea market is organized every day.

3.2 In-Depth Case Studies

The second scale of analysis is the in-depth presentation of individual cases with a written description supported with photos, aerial images taken from Google View and schemes by the authors. The in-depth analysis of a selection of the case studies allowed us to gather complex viewpoints and feedback on barriers, enablers, and drivers that these UCPs encountered. We present insights on each chosen metabolic question through the description of an in-depth case study. For food and composting, we present the mapping and analysis of the practices of "*Chant des Cailles*", an urban farming project that developed into a cooperative in a residential part of Brussels. For the built environment, we discuss "*Woningen 123 Logements*", a temporary occupation project based on housing and common infrastructures in an unexploited public building. For construction materials, we present "*Rotor DC*", a cooperative enterprise dealing with the recirculation of construction materials. Finally, the recirculation of objects, textiles, appliances, and furniture is analyzed through the historical practice of "*Le Petit Rien – Spullenhulp*", a charity foundation which has existed and worked within the social economy across the BCR and beyond since the 1930s. These selected case studies allow us to gather knowledge from stakeholders and describe the material impacts of these practices, while paying attention to spatial layouts. Finally, they allow us to analyze drivers and evaluate barriers and enablers and their impact on affirming and mainstreaming these circular initiatives.

3.2.1 Food and Compost: The Example of an Urban Farm Occupying Since 2012 an Unbuilt Site

The first in-depth case study of UCP deals with an urban farming project called "*La Ferme du Chant des Cailles*". Situated in the southeast part of the BCR, it is at the heart of a *cité -jardin* of the 1920's (the *Logis-Floréa*l) developed as social housing for the municipality of *Watermael-Boitsfort*. Today, this is an affluent neighborhood, partly due to its green areas and the mix of historical social housing complexes with middle and upper class dwellings. This UCP is exemplary for the way in which different stakeholders engage in gardening from a wide angle, inducing multiple practices and developing different hands-on knowledge, while exploring inclusive governance models. These ambitions predate BCR *Good Food* policy (2015) aiming at increasing local and sustainable food production, both through the expansion of professional (commercial) urban agriculture and noncommercial urban agriculture (self-production gardens, social agriculture). This urban farm started in 2012 and has been run jointly by residents and professional farmers. The various activities are grouped together under the legal form of a nonprofit organization. It occupies a surface of approximately 2.5 ha of land publicly owned by the social housing agency. This association federates five different initiatives: two driven by citizens and three professional ones. Local inhabitants created the collective garden (*Le Jardin Collectif*), while the "sustainable district" initiative (*Quartier Durable Logis-Floreal*) organizes events and manages collective compost and a henhouse. Since 2016, the professional activities present on site are grouped under the legal form of a cooperative divided into three professional "poles": the vegetable gardeners (*Les Maraichers du Chant des Cailles*), shepherds and dairy farmers (*Bercail*), and the cultivators of aromatic plants (*Les Aromatiques du Chant des Cailles*). The gardeners produce vegetables which are distributed *via* a year-round self-harvesting subscription system based on the model of community-supported agriculture. There is also a self-harvesting flower field open to the whole district. In 2019, the cooperative published the following figures: 6,300 h of paid work (equivalent to 3.7 full-time positions). There are 394 subscribers to the field; 12% of the subscribers are tenants of the surrounding social housing.

Figure 4 also shows the different sectors and activities on the site: vegetable gardens on 35%; the sheep breeding, dairy products, meat, and wool on 25%; the collective garden with chickens and compost on 12% of the site; the herbs garden on the remaining 2%; and a collective space in the center. **Table 2** synthesizes the key features of this UCP. The urban faming project has recently expanded to new sites (St. Anne and Rouge-Gorges for the meadows and a cheese workshop and to Overijse for more land to cultivate). The original site is being threatened by disappearance or mutilation as 70 social housing units are planned. A publicly financed research project (*SAULE*) tested scenarios of ways of integrating housing and urban farming, yet the continuation of the project on site is currently questioned.

3.2.2 Unexploited Buildings: The Example of a "Squat" Organization Occupying Buildings for Housing Since the Early 2000's

The second case study, dealing with unexploited buildings, formulates an answer to the structural need for affordable and accessible housing. *Woningen123Logements* (in their occupation of the building situated on *123 rue Royale in Brussels*) (**Figure 5**) is a good case study as it unfolds the link between "squat" movements and establishment of an advocacy nonprofit association promoting the occupation of empty buildings as housing. By analyzing the trajectory of this practice, and by claiming it as a UCP, we wish to question (within the circularity-driven discourses) inclusive and socially just approaches that tackle a clear urban need (housing). The way in which this need is met is by occupying an unexploited building (a former office space) and structuring a community around it. *Woningen123Logements* is a nonprofit organization catering to a multicultural solidarity-based residency, where its occupants are people who want to participate in a life project that is different from classic housing. What they had in common is having difficulties in finding accommodations (in the context of a housing crisis or for more personal reasons) and felt the desire to live in a collective and solidarity-based environment. The building was occupied in 2007, as part of a larger "squat" movement which reclaimed unexploited buildings across the BCR. The owner of the building was from the Wallonia Region and the squatters, after a first break-in, had a temporary leasing contract that allowed them to legally establish onsite (that lasted until it was sold in 2018).

The building is located at *123 rue Royale* in a central part of the town characterized by large office buildings, in between the central and North station, neighboring the European institutions. In 2007, it was an unused office building comprising seven floors of approximately 500 m^2 and a ground floor of approximately 800 m^2, for a total of approximately 4,300 m^2. From 2007 until 2018, around 60 people were registered as residents. In 10 years, the *123 rue Royale* has accommodated about 600 people in its different buildings, for some for 1 year, for others 10 years. In addition, the temporary occupations can also play a role in the emergency reception of homeless people and alternative travelers: the *123 rue Royale* made more than 1000 nights per year available through the guest houses (FéBUL, 2017). Each floor had 7–12 registered inhabitants with generous rooms sharing a common kitchen and living room. On the ground floor, a bike repair workshop was located, along with a community bar hosting a free-price canteen once a week and an events and party space. Unsold food (*récuperation*) was collected daily and a space on the ground floor was used to display and share it. On another floor, a free shop was established for exchanging clothes. In addition, waste from electrical and electronic equipment was informally reclaimed, repaired, and put on sale in a free-price shop onsite. The association *Woningen123Logement* was constituted while this occupation went on and still exists even after the evacuation of the building on *rue Royale 123*. The association aims at finding alternative and concrete solutions to the housing crisis by reallocating empty buildings into housing in a dynamic of self-management (*auto-gestion*) of people (as a collective and as individuals), where its functioning is based on a community-based work (participative dynamics, development of collective projects, and management of projects by the inhabitants themselves). The building was sold in 2018 to a real estate business specialized in student housing. The nonprofit organization has been active in looking for a new place to occupy, but after 3 years, the community dispersed. The student housing that was subsequently built opened its doors in 2021 and offers 131 accommodations, around 100 euros above the average market price (around 560€ all incl. per month, while the regional average is 470€). **Table 3** summarizes the case study.

3.2.3 Construction Materials: The Example of a Cooperative Salvaging and Reselling Construction Components Since 2016

Rotor DC (**Figure 6**), formed in 2016, is a spin-off of the nonprofit association *Rotor asbl-vzw*, founded in 2006 with the aim of developing a cooperative design practice that investigates the organization of the material environment. *Rotor DC* is a business salvaging the components of buildings by dismantling, cleaning, and refurbishing them (when needed) in order to resell them. Its vocation is to promote and facilitate the reuse of building components as a strategy on the path toward a more resource-efficient material economy. Besides running a store, they provide assistance to building owners, contractors, and architects. They aim at reducing the quantity of demolition waste by salvaging goods, and often the salvaged goods offer a higher quality than new ones. Promoting reuse could allow the BCR to lower the environmental impact of construction materials and also preserve historical elements from buildings by diverting them from the waste stream. *Rotor DC* is developing a highly experienced team in the dismantling, conditioning, transporting, cleaning, and preparation of a wide variety of sellable materials (either online or in the shop). The development of knowledge on how to select, dismount, clean, refurbish, and sell components and materials took them over 10 years to constitute. They salvage bricks, ceiling, doors, floors, furniture, garden elements, metallic hardware, lighting, partition walls, sanitary equipment, stairs, technical equipment, wall cladding, wood, pieces of scenography, and artwork. They collaborate with building and demolition contractors, architects, public actors, and property management companies, etc., fostering the ambition of using reclaimed materials in large-scale projects (typically, in public tendering).

In 2018 (a year with fewer quantities than 2017, but a greater turnover) 160 tons of materials were reclaimed by *Rotor DC*, materials which would have ended up in mixed waste containers, while in the whole BCR, it is estimated that approximately, 600,000 tons of construction and demolition waste are generated annually. *Rotor DC* is in a central mixed-use area next to the canal and close to the south station. This zone is the largest "*strategic re-development area*" in the BCR, and it is undergoing an urban renewal project (*Plan Canal*) aimed at reintroducing housing and services into former industrial sites along the canal. *Rotor* has a temporary occupation lease given through *Citydev*, a public organization developing subsidized housing for the middle class and productive/industrial spaces. They bought the site (a former chocolate factory) in 2016 and allowed *Rotor* to rent a part of the space for 5 years, while they prepared the reconversion project, called *City Gate III*. The project plans to build 16,000 m^2 of housing, 2,000 m^2 for small and medium enterprises, 1,000 m^2 of facilities, and 1,000 m^2 of shops. Currently, *Rotor* occupies a total of 5,200 m^2 of the former industrial infrastructure: 250 m^2 of offices, 1,500 m^2 of shop with ateliers and storage, 150 m^2 of independent ateliers, and 850 m^2 of storage; for a total open space (courtyard, logistics, and storage) of 2,500 m^2, the total covered space is 1,750 m^2, of which only 250 m^2 are heated. The shop, storage, and workshop spaces are fundamental as they allow *Rotor* to offer a wider timeframe for potential buyers, get to know, and eventually rework the material before selling it (i.e., for parquet, tiles, toilets, etc.) and work on the intangible value of the salvaged goods (cultural heritage and archiving). *Rotor asbl-vzw* and *Rotor DC* consider it one of the main "strengths" of their practice to have the offices and warehouses in the same place. They refer to it as a "fundamental organic link in-between intellectual, logistical, and even human components" (Interviewee #1, 2019). A large material stock that works as the "Ali-Baba cave" is important for them as this federating space allows the aura of some materials that are chic or unanimously appreciated to "rub off" on other less "attractive" materials. **Table 4** summarizes the case study.

3.2.4 Objects and Stuff ("*Brol*"): The Example of a Charity Organization Founded in 1937

Les Petits Riens - Spullenhulp (PRS) *i*s a nonprofit organization established in 1937 by *Abbé Froidure*, a Belgian Catholic priest

FIGURE 7 | Locations in the BCR, aerial views and street-views from Google Maps of three kinds of infrastructures "*Les Petits Reins-Spullenhulp*" exploits in the BCR (one large warehouse, a large urban shop, and a small one) and a street-view of the warehouse and shop in the municipality of *Ixelles (Rue Américaine 101)*. September 2021. By the authors.

TABLE 5 | Summary of the in-depth case study "*Les Petits Riens-Spullenhulp*".

In depth-case study	***Les petits Riens – Spullenhulp* charity initiative running secondhand Shops**
Spaces	A sorting center in an industrial area: the warehouse has a footprint of 8,000 m^2 on a site of 1.6 ha. In the BCR there are 25 stores (4 in the Wallonia Region): 21 selling clothes and accessories and 4 selling various objects, furniture, appliances, toys, bikes, etc. In the BCR there are 63 deposit-points and 767 containers/bubbles for textile collection in Belgium. The kind of spaces are for: machineries for sorting, workshops for cleaning and refurbishing and preparing to sell, logistic spaces for transportations, storage, shop equipment, offices, training centers, housing accommodating people in need, etc.
Flows	The sorting center processes about 8,000 tons of donations each year (approximately 1,000 of objects, appliances, furniture, toys, etc. and 7,000 of textiles). For textile: 15% is sold in *Les Petits Riens'* shops, 30% is recycled, 32% exported, and 20% is trashed For objects: 40% is sold is in *Les Petits Riens'* shops, 40% is recycled, 4% exported, and 10% trashed. 10,000 household appliances have been refurbished in 25 years The revenue in 2020 was 8.5 million euros (12.4 in 2019 and 11.7 in 2018). They re-circulate: clothes, furniture, household appliances, dishes, books, toys, and sports items, etc.
Actors	Workers: 328 total full-time equivalent positions created in a year (the sorting center has approximately 200 people working). Workers are mainly people in socio-professional integration (social economy), trainee people in precarious situations, the homeless, and people transitioning toward stable accommodation (in 2020, 219 homeless people were welcomed, 129 people were helped at home, and 19 were hosted while looking for a stable domicile) 273 volunteers, clients (including also ones with a very low-budget), public institutions, and nonprofit associations (. . .)
Founding year	1937-ongoing
History	Charity foundation recuperating objects and textiles to run secondhand shops (within the social economy) and finance social projects
Location	Spread all around the BCR: a large facility in the industrial area and then capillary network of smaller shops, warehouses and collection points.
Legal structure	Nonprofit association

TABLE 6 | Comparative analysis of the four in-depth case studies following the research framework (spaces, flows, and actors), by the authors.

In depth-case study	Chant des Cailles	Woningen 123 Logements	Rotor DC	Les petits Riens – Spullenhulp
Urban circularity Aim #1: Reduce footprints (narrow/slow/close material loops)	++ Until now, not very impactful in terms of quantities (too small) but rather in know-how and synergy development across actors and spaces. It still needs time to root in the BCR and upscale or federate with other practices in order to have considerably positive impacts. Positive impacts on raising awareness among communities/citizens/neighbors. Positive impact on knowledge development from hands-on practices	++ Until now, not very impactful in terms of quantities (too few) but rather in experimentation of alternative ways of living in more frugal manners. The BCR public institutions still need to recognize and give space to these practices to root and federate in order to have considerably positive impacts. Positive impacts on raising awareness among communities/citizens/neighbors. Positive impact on knowledge development from hands-on practices	++ Until now, not very impactful in terms of quantities (too small) but rather in know-how and synergy development and raising material-oriented awareness in architectural practices. It still needs time to root in the BCR and upscale or federate with other practices in order to have considerably positive impacts. Positive impacts on critical discourses and raising awareness among spatial designers and public institutions. Positive impacts on knowledge development from hands-on practices	+++ Significantly impactful in terms of quantities, know-how, and synergy development across actors and spaces. Positive impacts on raising awareness among communities/citizens/neighbors. Positive impact on knowledge development from hands-on practices
Urban circularity Aim #2: Socio-spatial resilience and inclusivity (accessibility and affordability)	++ Currently, subscribers are mainly wealthy and environmentally aware. It is part of a network of local agriculture initiatives. It provides a space open to everyone. They organise events on site and are present on local weekly markets.	+++ Targeting people interested in alternative ways of living with low budgets and legally ambiguous statuses	+ Mainly appealing to a wealthy and environmentally aware public. Contributing to disseminating initiatives. Developing open-access publications with guidelines to perform inventories on salvageable components and materials	++++ Open to all publics, very mainstreamed for both low-income people, middle-income classes, and sometimes wealthy people (for vintage items and well-priced products) as well as environmentally aware ones
Urban circularity Aim #3: Environmental healthiness	+ + + Water infiltration, enhancing biodiversity, preserving living soils, lowering heat island effects, and reducing (pollution of) logistics of food flows coming from afar	+ Reducing waste and reducing (pollution of) logistics of materials and food from afar	+ Reducing waste and reducing (pollution of) logistics of materials from afar	+ Reducing waste and reducing (pollution of) logistics of goods
Barriers	1. Spatial precarity: under threat to lose the exploitation field or to mutilate it as it is allocated for the development of 70 new social housing units	2. Eviction due to the selling of public property to private investors developing high-standard student housing 3. Lack of recognition	4. Temporary and subsidized occupation that comes to an end 5. High prices of large urban spaces 6. Too low price of new materials and too low price for demolitions and waste processes 7. High cost of labor in Belgium 8. Obligation to salvage and sell mostly high-value components	9. Too low quality of cheap new products that end in the value chain, provoking extra work for sorting and logistics 10. Concurrence of online platforms where individuals sell high-quality items peer-to-peer, subtracting them from charity networks 11. COVID-19 pandemic restrictions on sales in shops
Enablers	1. Introducing in the land use plan a new category of "nourishing and fertile soils" to be preserved 2. Finding economic support from institutions to support professional training in farming and ongoing farming projects 3. Extending arable land by remediating sites, reclaiming spaces where to grow also above the ground 4. Promoting/expanding collective and private gardening and composting by multiplying initiatives and spaces at the local scales	5. Recognizing collective inclusive housing experimentation as important, 6. Supporting them with available locations/buildings, beyond precarious occupations	7. Support with location finding where to establish for at least 10 years 8. Higher price of demolitions (taking into account environmental externalities) 9. Lower taxation on labor in CE domains 10. Shift TVA from 21 to 6% on reclaimed materials 11. Create a test zone (both physically and metaphorically) where to experiment with CE practices	12. Raising awareness on problems arising from cheap, low-quality new products over consumption and waste 13. Creating a capillary system for collecting furniture, bulky items, and objects that still tend to be trashed instead of recirculated 14. Development and mainstream know-how on repairing and refurbishing broken objects, appliances, etc.

(Continued on following page)

TABLE 6 | (*Continued*) Comparative analysis of the four in-depth case studies following the research framework (spaces, flows, and actors), by the authors.

In depth-case study	Chant des Cailles	Woningen 123 Logements	Rotor DC	Les petits Riens – Spullenhulp
Drivers	1. Regional ambitions to reach 30% by 2030 of fruits and vegetables locally produced and consumed in the BCR	2. Exacerbated housing crisis 3. Cultural interest (in the aftermath of the pandemic crisis) to live in communities with shared large spaces rather than in isolated small units	4. Upcoming regulatory pressure to reuse materials and components in urban projects 5. Mainstreaming of CE concepts and practices	6 With CE policies, textile heavy environmental impacts are raising awareness on overconsumption and overwaste 7. Projects such as "Wood in Molenbeek" raised awareness on large material flows available in neighborhoods and on how to tackle them in a local and community-oriented manner

active in helping disadvantaged youth. This charity-oriented initiative is based on "social economy", meaning economic activities producing goods or services whose ethics are notably translated by the principle of service to the community, rather than for profit. They define themselves as a grassroots actor committed to the daily fight against poverty and social exclusion. Their priority is to help homeless people and any person in a precarious situation in Belgium. The economic activity of secondhand object collection, sorting, and reselling allows hundreds of people outside the classic work circuit to find employment, while the stores are affordable and accessible to all. They collect different types of goods: clothes, furniture, household appliances, dishes, books, toys, and sports items. The association collects in three ways: free pick-ups at home, drop-offs in stores, and containers/bubbles/boxes in the street. In 2020, there were 63 deposit points and 767 containers/bubbles for textile collection in Belgium. In 2015, the *PRS* opened a sorting center on *rue du Zuen* in the industrial area of the municipality of Anderlecht (BCR); this facility has a footprint of 8,000 m^2 of warehouse on a site of 1.6 ha (as a comparison, the neighboring Ikea has a warehouse with a footprint of 2.3 ha on a site of 5.3 ha). This center sorts about 8,000 tons of donations each year (approximately 1,000 of objects, appliances, furniture, toys etc. and 7,000 of textiles), and nearly 200 people are active on the site. For textiles: 15% is sold in *PRS* shops, 30% is recycled, 32% exported, and 20% is trashed. For objects: 40% is sold in PRS shops, 40% is recycled, 4% exported, and 10% trashed. PRS has a network of 25 stores in Brussels, 21 selling clothes and accessories and four selling also objects, furniture, appliances, toys, bikes, etc. Four shops are also present in the Wallonia Region (Les Petits Riens, 2021). **Figure 7** shows the spatial layout of the practice.

The annual revenues in 2020 (heavily impacted by COVID-19 pandemics) were 8.5 million euros (compared to 12.4 in 2019 and 11.7 in 2018). The association managed 16 million euros in 2020 (20 million in 2019) of which 61% came from the economic activity, 22% are public subventions, and 7% donations. The association proposes and manages a few social projects, such as *ad hoc* support for people in precarious conditions (medical and psychological help, training, couching to find a home, etc.), and they also opened few homes to house and help the homeless (and vulnerable people) to transition toward a more stable accommodation (Les Petits Riens, 2021). The PRS offers vouchers to people with financial needs to use in their shops. It also runs a work-training workshop called *Horizon* allows individuals to follow a year of practical and theoretical training in electromechanics aiming at revalorizing donated household appliances. Through Horizon, PRS claims that 10,000 machines have been refurbished in 25 years, and over 400 people have been trained. Other services to support occupational reintegration are also provided. The socio-professional integration of people who are far from the labor market is performed in collaboration with various public authorities and special taxation regimes. Furthermore, this association also relies on volunteers and interns (i.e., 273 volunteers in 2020). This association created a total of 328 full-time equivalent positions in 2020; nevertheless, it has a growing debt of over 2.5 million euros due to the impact of the pandemic on their main income activity of reselling. Two elements also affect the practices of secondhand clothing charities: the growing competition of commercial online secondhand platforms (that partially retain the most qualitative items within its network) and the high turnover of poor-quality cheap goods (i.e., fast-fashion clothes that end up overwhelming the collection points of charities or furniture breaking after the first disassembly). For clothing, the turnover (14 kg of clothes bought on average per person in Belgium and 6 kg were reintroduced into charity loops in 2019) creates huge quantities (30,000 tons of textile per year) of very low-quality goods, of which only 3–5% is resalable. Associations working in the domain (such as Oxfam and Emmaus) claim that the workload increased in selecting the goods, while the resalable percentage stays the same, creating economic challenges (RTBF, 2019). **Table 5** summarizes the case study.

4 DISCUSSION

4.1 Case-Studies' Comparative Analysis

The comparison, through the elaborated urban circularity frameworks, is a relevant exercise to be able to set a shared understating of a larger socio-cultural momentum and to point out barriers, enablers, and drivers that could steer sustainable urban transitioning from a holistic viewpoint. Of the case studies analyzed, some do not claim to be "circular". However, they are realities that were born within resource-conscious discourses and social movements, and therefore, in a

rather natural way, they belong to the culture of "circularity" according to multiple aspects. Yet, this comparison is not an evident exercise as each case study deals with specificities and exceptions. **Table 6** shows our attempt to establish a comparative analysis across the four cases. This analysis allows us to move from abstract knowledge, based on the implementation of principles, toward more concrete insights on factors influencing UCPs. Here some potentials and barriers of urban circularity can be discussed more concretely. These concrete case study descriptions also help bridge the current "gap" between CE and UC theories and complex terrain realities. Two main observations arose: 1) the more in depth the analysis is conducted the more complexities and specificities are encountered; 2) each case study is unique yet part of a larger movement.

4.2 Barriers, Enablers, and Drivers

Under the definition of barrier, we discuss factors that influence negatively the ability of a practice (UCP in this case) to develop and thrive. Enablers are seen as counteractions that could help overcome barriers. As with drivers, we investigate existing factors seen as external opportunities potentially fostering the development and embedding of UCP. Both drivers and enablers can also be seen as recommendations from the authors for the fostering and embedding of UCPs.

4.2.1 Barriers

In this section, we list the main barriers with a focus on spatial ones that we encountered in the four UCP case studies. Spatial precarity is listed in three of the four case studies: it emerges in recent UCPs that do not own or have long-lasting rental contracts. The urban farming project is under threat of losing part of the original exploitation as this area has been allocated for the development of 70 new social housing units. The squatting movement was evicted and did not find a place able to host its former inhabitants. The salvaging and reselling cooperative of construction components and materials is also in search of a new site as their temporary contract came to an end, and they have to leave the space for a mixed development (catering mainly to middle-class housing units). High prices of large urban spaces are a main barrier to their future projections. Their ambition to stay within urban contexts is questioned by the scarcity of affordable and accessible sites. In both secondhand reselling of construction components and materials and objects and textiles, economic barriers have also been identified, namely: the too low prices of new materials (often suggesting bad-quality and fast-ware goods), the too low taxation on waste production, and the very high cost of labor in Belgium. These factors, together with rising real estate prices, translate into a tendency to focus mainly on high-end value chains in urban production. This implies the exclusion of the larger part of the urban population from having access to locally sourced products (ideally less polluting and sometimes better quality).

Urban development actors can be seen as instrumentalizing temporary occupation agreements: they open their spaces to UCPs to increase the value of their site, while ensuring that no illegal squatting takes place. Thus, they ensure the future availability of the site. If temporary occupations help the initiation of UCPs, uncertainties unveil in the following operation of relocating them, hampering their ability to develop a long-term project. For businesses, temporary occupation contracts of less than 10 years are not really helpful: as (despite the advantageous rent) all the investments in settling in the space are to be amortized over a too short period of time. These spatial barriers impact the economic challenges that these UCPs are facing, influencing their business plan and the kind of actors they address. High-added value chains are the ones that can compete with high real estate prices, but these value chains are not inclusive (large parts of the population cannot afford them). Furthermore, these high-added value chains are not able to tackle the vast amounts of materials going to waste as they are obliged to select mainly valuable pieces. Real estate prices are factors greatly affecting the establishment of UCPs, but this goes together with urban development trends at the local level as on the global one. In huge cities with an international high speculation dynamic (as in London) and in cities/regions with circularity-inspired ambitions (as in Paris, Amsterdam, or Brussels), land and space are finite resources, becoming less and less accessible for value-chains that do not produce a high-added value.

4.2.2 Enablers

The enablers that emerge from the comparative analysis (**Section 4.1**) are quite multifaceted and depend on the specificity of each UCP. Nevertheless, three common tracks emerged: 1) re-thinking land use to guarantee the preservation of valuable urban functions (e.g., urban "nourishing, and fertile soils"); 2) using public institutional support (subventions, changing specifications in tendering and selection criteria, regulations, taxation, etc.) to leverage the development of UCPs; and 3) engaging with a widespread (mainstreamed) cultural shift toward more frugal, resilient, and inclusive behaviors and urbanities. All cases bring to light the incredible asset that a well-distributed and embedded spatial presence in urban contexts represents. The "*Les Petits-Riens*" case becomes here an important one to suggest new perspectives on how to anchor practices in an urban context, allowing them to tackle significant quantities of flows, thus moving beyond high-added value chains (providing accessible and affordable goods for all). In addition, this UCP provides a virtuous example on how to structure a capillary network of very different kinds of infrastructures in the city to provide a well-distributed (and embed) service of proximity.

4.2.3 Drivers

The drivers in the BCR are few and vary per kind of UCP. In urban farming practices, regional ambitions to reach 30% by 2030 of fruits and vegetables locally produced and consumed is the main driver from a policy perspective. The exacerbating housing crisis will not be solved soon if we are to wait for the building of the missing social housing units. Thus, more attention should be dedicated to alternative ways of catering for affordable and accessible housing, for example, transforming unexploited office buildings into affordable housing. Also, a rising cultural interest (exacerbated by the pandemic) to live in communities with shared large spaces rather than in isolated small units could play a pivotal role in proposing

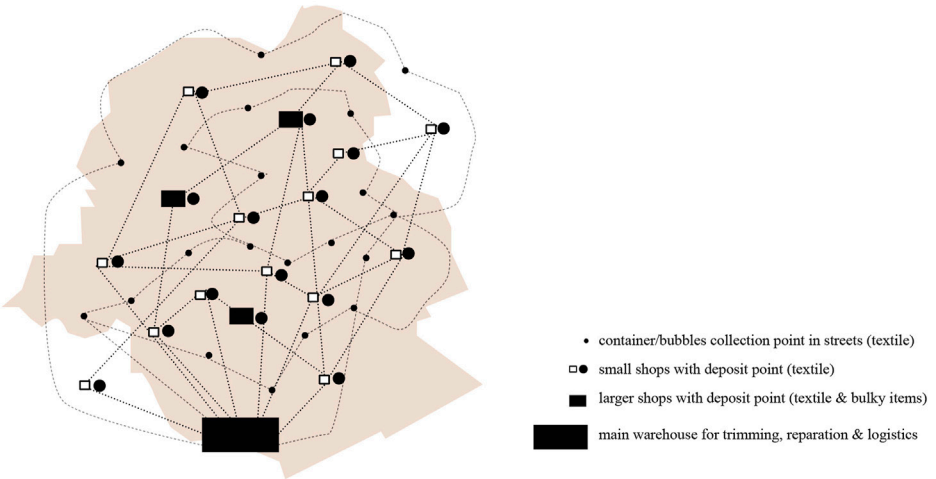

FIGURE 8 | Diagram showing the spatial constellation of *Les Petits Riens-Spullenhulp*, by the authors.

new experimental housing communities. Upcoming regulatory pressure on urban and architectural projects in the BCR will oblige projects to reuse existing elements to a maximum extent, while mainstreaming CE concepts and practices. The awareness on the heavy environmental impacts of fast-consumption goods (e.g., textile industry) is rising and sometimes targeted in specific policies. Nevertheless, new large commercial surfaces are being developed in cities offering extremely cheap products; thus, we question whether the expansion of such offers is compatible with CE and UC ambitions.

4.3 How Space Matters

The four case studies of UCPs are fully inscribed within UC ambitions. They cover multiples aspects of urban systems: housing, food production, construction material, and object recirculation. Even if sparked by a multifaceted set of cases, shared issues appear which allows us to problematize key factors (such as spatial ones), affecting the ability of UCPs to establish their activities with a long-term perspective.

What emerges is a complex picture, where the most recent UCPs are in precarious conditions and struggle to affirm themselves in urban contexts. Access to space and land in the BCR resulted in one of the most recurrent barriers to the rooting/embedding of UCPs in the BCR, as in other European cities. Clearly, the price of real estate is one of the main causes but not the only one. Frictions appear in political agendas where the need for more housing, productive spaces, urban agricultural land, and green–blue infrastructures compete over the same limited square kilometers. Concurrently the redevelopment and systematic filling of the last available urban "void" (often brown fields) create perverse logics: the need to rush the completion of projects without leaving the time needed for other paradigms – more resource-conscious, inclusive, and frugal (i.e., circular) – of urban planning culture to be studied, tested, and established. The pace at which available plots are still being built in the BCR is putting pressure on (and ultimately threatening) many existing activities, some of which are contributing to the regional circular agenda. Temporary occupations, often cited as an exemplary circular solution, witness increased criticism as they often became a structural limit to long-term perspectives. Land scarcity is putting pressure on urban production spaces and agriculture land bordering urbanizations and is hampering practices that propose short circuits (Williams, 2019; Lestrange et al., 2021). If we wish to lower the impacts of logistics and transportation and valorize the existing resourcefulness of cities, developing the proximity of services providing for urban needs is essential. Some of these services have, in time, been moved further away from cities in time (e.g., industries, storages, agriculture, and farming lands, etc.), while some of them are now being encouraged to move closer to the urban center (where most consumption takes place). Logistic as well as productive, and agriculture spaces are fundamental to the realization of more circular urbanities. Thus, we claim that space is a key resource in the implementation of circularity ambitions, strategies, and practices. Historical practices such as *Les Petits-Riens* over 80 years have developed a broad presence on the territory: space is an asset developed in time. This practice has three main kinds of spatial layouts: 1) a large deposit in an industrial area at the periphery of the region for heavy logistics, 2) urban warehouses associated with stores where larger items are sold (i.e., furniture, appliances, bikes, etc.), 3) a constellation of smaller reselling points distributed in commercial areas all around the region, and 4) a capillary distribution of deposit points in the forms of containers/bubbles (as **Figure 8** shows). In addition, the ownership of spaces and long-lasting leasing contracts are emerging as advantages in the embedding of UCPs.

4.4 Urban Circularity and the Landscape of Urban Circularity Practices

The pathway toward more UC is seen here as the sum (or better: multiplication) of partial attempts to foster UC through

more frugal, more resilient, and inclusive practices. Each practice is partial (constrained in its means and impacts), yet fundamental. Through the atlas of UCPs, we could initiate an analysis of the landscape of practices in the BCR. Maps pinpointed different kinds of UCPs, while heatmaps allowed us to identify existing clusters. Urban agricultural farming practices are taking place on the periphery of the BCR, while many smaller vegetable gardens are "slipped" into denser urban fabrics. They seem to be well-distributed except in areas dedicated to tertiary activities (e.g., the European institutions neighborhood). Temporary occupation projects and "squat" movements take place in a different part of the city, sometimes in unexploited offices in central locations, others in industrial areas where renewal projects are taking time to develop, or in smaller buildings in residential areas. Historical well-established practices are making use of the differentiation of spaces and locations to structure their ecosystem across the BCR and beyond. They have access to spaces in the consolidated urban fabric (outside strategic urban renewal areas). We can conclude that the most recent UCPs are found in spatially precarious conditions and struggle to affirm themselves in urban contexts. They are subject to temporary occupations that are located exactly in these redeveloping hot spots. This often allows UCPs to find convenient central locations, even if for a shorter time span.

4.5 Urban Design and Spatial Planning in the Transition Toward New UC Paradigms

We discuss here how spatial disciplines have been engaged with creating ambitions, policy plans (PREC for example), manifestos, and projects aiming at translating "circular" ambitions into practices. The role of professionals working on spatial planning and design is relevant in the debate on circularity as it lies at the crossroads of science and humanities, and it is based on multi-scalar reflections, on multi-actor interactions, and trans-disciplinarity (Grulois et al., 2018; Marin, 2019). Furthermore, these disciplines can have heavy environmental impacts: they influence construction materials and waste flows, energy performances, water management, land use, etc. The research by design, testing hypothesis in spatial projects (making use of scenario-based and co-creation methodologies), can bring significant insights to urban transitioning questions (Viganò, 2012; Zaman et al., 2014; Marin, 2019).

We invite urban planners and designers to engage with UC perspectives and embrace this radical shift in their profession. Spatial planners and designers are charged with heavy responsibilities as every conversion of permeable soil is not only a resource-consuming action but—as Brand (1994) shows in his pace-layering scheme—it implies changes to land and the site. These supports of urban projects are the ones with the slowest rate of change (compared to the layering of the construction above). We propose that designers shall become mediators and caretakers of the existing built environment and land. They need to bear in mind that permeable spaces have a crucial role in ecological transitioning as they contribute greatly to ecosystem regulation (biodiversity, air quality, urban heat island effects, and water management). Thus, permeable spaces should be protected and promoted at all levels, on publicly and privately-owned lands. In addition, the biological value of fertile soils takes a very long time to reconstitute and should be considered as one of the most precious local resources of all. It is also important to pay attention to existing UCPs, especially recent ones, and study the spatial layout of well-established ones. Importantly, regional policies should help the development of a long-lasting perspective (beyond temporary uses).

5 CONCLUSION

The conclusions of this article are, therefore, four-fold: first, to contribute to outlining of a more contextual, spatialized, and inclusive discourse dealing with circularity ambitions at the urban scale; second, to propose a research framework to help bridge the gap between regional circularity ambitions and terrain realities (with a focus on embedded and inclusive examples of circularity socio-spatial practices); third, to make a state of the art of a broad range of existing circularity practices in the BCR (some historical and some new) dealing with daily consumption goods (i.e., food, buildings, construction components, and materials/objects); and lastly to propose a few urban design elements as a basic toolbox to be used in public tendering when renovating public space, thus promoting inclusive practices in order to broaden the public involved.

We proposed a methodology to spark holistic reflections and approaches to UC. We first gave a definition of UC and UCPs. We then elaborated on metabolic questions and a framework in order to analyze case studies of UCPs. Two scales of analysis were interwoven: at the regional scale, we created an atlas of different kinds of UCPs, thus mapping the network of regional actors in their urban locations; and at the scale of the single case study, we developed an in-depth description of four chosen UCPs. We selected four metabolic questions to be tackled at both scales. For the four in-depth UCPs we made a comparative analysis in which their ability to tackle UC ambitions was discussed. The comparative analysis allowed us also to list a series of factors (barriers, enablers, and drivers) affecting UCP mainstreaming and embedding. By underpinning spatial barriers emerging from this research, we wish to share concerns about land consumption logic and unaffordable urban infrastructure. Also, we wish to provide insights on how to tackle such issues from a spatial planning perspective. We ended by defining potential leverages for the establishment of a circular urban planning culture in the near future, underlining the crucial role that urban planners and designers play in this matter.

Limitations of this research are to be found in the non-exhaustivity of the case studies presented. Spatial analysis could have been developed in a more in-depth manner by zooming in on specific zones and performing a spatial analysis of multiple metabolic questions at the same time. Urban morphology studies could also have been implemented in the scrutinized areas. Furthermore, any

attempt to create a database is dealing with a specific timeframe, and a great challenge is how to update it over time.

For future perspectives, we invite academics, local institutions, businesses, associations, citizens, and individuals to federate around UCPs to engage and support them. We invite public institutions to reconsider current urban planning and design paradigms, weighing projects according to their holistic contribution to the fostering of UC ambitions. We invite architects and urban planners to engage with the renewal of their profession, questing projects from a UC perspective, therefore aiming at the valorization of resources at hand and striving to enhance the health of ecosystems and practices of inclusivity. If the challenge to transition toward more ecological paradigms is currently mainly a cultural one, it requires a shift in the way we explore and disseminate notions such as "circularity" in an inclusive and empowering way. It is important to share purposes beyond fragmentation, following ideas that allow for a collective "making sense" out of daily practices.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

Conceptualization, GV and AK; investigation, GV; methodology, GV and AK; supervision, AK; visualization, GCV; writing—original draft, GV; writing—review and editing, GV and AK. All authors have read and agreed to the published version of the manuscript.

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